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SANTA CLARA VALLEY WATER DISTRICT

FOUR YEAR COMPARISON OF SALINITY IN TIDAL STREAMS IN SANTA CLARA COUNTY (1998-2001)

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INTRODUCTION

The purpose of this study is to help define maximum annual salinity levels, salinity gradients, and general locations of the extent of saline water intrusion in the tidal streams of Santa Clara County. This study was conducted to provide baseline information to the Santa Clara Valley Water District (District) Ecological Services Unit.

Northern Santa Clara County is within the South San Francisco Bay watershed. Tidal watercourses, San Francisquito Creek, in the West, and Coyote Creek, in the East, define the boundaries of the County with its northern neighbors, San Mateo and Alameda Counties, on the west and east shores of the Bay respectively. Several of Santa Clara County's streams are tidal in their lower reaches due either to a direct connection with the Bay or one of its major tidal sloughs. The entire northern edge of the County is traversed by a series of tidal marshes, streams, sloughs, and salt ponds.

Salinity levels of tidal streams influence the type and distribution of associated plant and animal communities found within and adjacent to the waterways. These communities can also be affected by the associated diurnal hydrologic regime. Therefore, both the salinity gradient and tidal status may, either directly or indirectly, influence the distribution of individual species including several special-status species such as the salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*), California clapper rail (*Rallus longirostris obsoletus*), and California red-legged frog (*Rana aurora draytonii*).

Tidal extent is often defined as the upstream limit where surface water levels fluctuate due to the tidal cycle. With respect to this study, tidal extent refers to the upstream limit of saline water intrusion (> 1.0 part per thousand), rather than the portion of the stream where changes in water elevation occur. Many times these definitions refer to two different locations.

This study documents the salinity characteristics of tidal watercourses within the county once each year. The sampling period is timed to coincide with the time of year in which salinity levels in the South Bay system are typically at their maximum (late summer and early fall). Sampling is performed on the highest tides during which both the overall salinity within the streams and the tidal intrusion upstream are expected to be at their highest levels. Sampling is conducted once on each stream at approximately 1,000 to 2,000-foot intervals, during the course of a single high tide event.

This study provides only a "snap shot" view of the approximate maximum salinity levels within the creeks and provides estimations of the upstream limits of saline water intrusion for each associated year. Locations of specific salinity levels and the extent of salinity influence are variable over very short, as little as hourly, and longer periods of time. Tidal heights and salinity levels fluctuate yearly, seasonally, and diurnally due to a multitude of variables including: recent rainfall, annual rainfall, urban runoff and other anthropogenic water inflow, and large scale climatic and gravitational conditions.

The sampling conducted during the 2001 water year is the fifth of its type following similar studies in 2000, 1999, 1998 (Falco & Rankin, 1999), and 1997 (Kook, 1997). Results of the 1998 through 2001 studies are presented and compared in this report in a summary format. The data collected in 1997 contained several inconsistencies which made the data non-comparable and, therefore, it was not incorporated into this multi-year analysis.

METHODS

During 1998 - 2001, sampling occurred annually, in the late summer and early fall, when salinity levels in the South Bay are expected to be at a maximum. The range of rainfall which occurred during each sampling season and the total rainfall from the previous water-year is summarized in Table 1 below. Rainfall data prior to each annual sampling period from July – August, was negligible (< 0.04 in) for all four years of the study. Average annual rainfall in Santa Clara County is approximately 15 inches in the valley regions and up to 40 inches in the Santa Cruz Mountains.

Table 1. Rainfall in Santa Clara County Pertinent to the 1998 – 2001 Sampling Periods.

Water-Year *	Sampling Period	Range of Rainfall During Sampling Period **	Range of Total Rainfall in Previous Water-Year **
1998	September 8 - November 5	0.5 - 1.1" (late Oct.)	24.3 – 78.4" (El Nino year)
1999	August 11 - October 12	0.1 - 0.2" (early Sept.)	11.1 – 39.1"
2000	August 2 - October 27	0.5 - 2.2" (late Oct.)	13.2 – 44.1"
2001	August 22 - November 2	0.2 - 1.1" (late Oct.)	11.0 – 35.0"

* Each water-year begins July 1 and extends through June 30 of the following year.
** Rainfall data is based on the District's four rain gages in the West, Central, Northeast, and South portions of Santa Clara County.

Working under the assumption that higher tides carry a greater volume of water and, therefore, drive the tidal limits of a creek further upstream, sampling only took place during "spring tides" predicted to be 5.5 feet (MLLW) or higher at the Golden Gate Bridge.

The National Oceanic and Atmospheric Administration (NOAA) predict that high tides reach the South San Francisco Bay, on average, 1 hour and 15 minutes after high tide at the Golden Gate Bridge. Therefore, each sampling period began no earlier than the predicted high tide at the Golden Gate Bridge and ceased 3 hours later (i.e., sampling began approximately 1 hour before and ended approximately 2 hours after the predicted high tide in the South Bay). All streams were sampled in their entirety within a single high tide event.

During 1998 sampling in the east flood control zone, it was observed that tides took over an hour longer to influence the upper tributaries in this portion of the County. Subsequently, sampling sessions in 1999, 2000, and 2001 were delayed by 60 - 90 minutes to compensate for the tidal delays at these eastern locations within the South Bay.

Virtually all stations sampled during the 1998 study were also sampled in 1999, 2000, and 2001 (Table 2). For each session, sampling began at the downstream end of each stream and continued upstream, in accordance with Global Positioning System (GPS) coordinates collected in 1998 (approximately 1000 foot intervals based on the District's 1993 "Yellow Book" Maps of Flood Control Facilities and Limits of 1% Flooding). A Trimble Pro XRS GPS receiver with a TSC-1 data collector was used to re-locate the original 1998 locations.

Sampling proceeded upstream until two consecutive stations registered less than 1.0 part per thousand (ppt) on a Yellow Springs Instrument (YSI) model 30 salinity, conductivity, and temperature meter. In 1999, streams which consistently registered readings between 0.5 and 1.0 ppt were sampled for an additional mile upstream to ensure that the salinity readings were not faulty or fluctuating. No significant salinity fluctuations were detected with the expanded sampling regime in 1999, and therefore the expanded methodology was not performed during the 2000 or 2001 studies.

In 1998, vertical salinity stratification was noted as an important and potentially influential factor at many stations, and therefore in 1999 through 2001, salinity and temperature measurements were taken at the surface (< ¼ meter in depth) and at the bottom (< ¼ meter off the bottom) of each sampling station. Additional field observations recorded at each station included: time of sampling, status of the tide (incoming, slack, or outgoing), estimated tidal elevation (over-bank, at bank, or below bank), and general vegetation features (keyed to Genera level).

Sampling for all stations occurred within the active channel. In 1998, this required an extensive walk through marsh and emergent vegetation to reach open water. During 1999 through 2001, an extendable pole was used to reach the center of the active channel and the larger waterways (Guadalupe Slough, Guadalupe River/Alviso Slough, and Coyote Creek) were sampled by boat.

During 1999 and 2000, the sampling regime on Guadalupe Slough was expanded to include the entire length of the waterway. In order to complete sampling on the slough within a single high tide event, samples were taken at 2000-foot intervals. During 2001, time constraints due to access difficulties did not allow for sampling on the lower reaches of Guadalupe Slough. From 1998–2001, access difficulties to lower Alviso Slough and Coyote Creek precluded sampling these waterways in their entirety.

GPS coordinates were collected for any new sampling stations established during the 1999 through 2001 sampling seasons using a Trimble Pro XRS GPS unit accurate to sub-one meter. Both the original 1998 GPS coordinates and the new 1999, 2000, and 2001 coordinates were used to create an Arc View Geographic Information System (GIS) map of all sampling locations and depict salinity levels for all 4 years.

Table 2. Approximate Annual Sampling Limits (1998 – 2001) using the 1993 "Yellow Book"

Stream Name	Approximate Sampling Limits	"Yellow Book" Page Numbers
San Francisquito Creek	3+00 – 110+00	1, 2
Matadero Creek	0+00 – 153+00	2, 16, 17
Barron Creek	0+00 – 18+00	17
Adobe Creek	0+00 – 180+00	2, 17, 32
Permanente Creek	3+00 – 165+00	17, 32
Stevens Creek	7+00 – 130+00	17, 18, 32
Sunnyvale West Channel	0+00 – 100+00	19, 33, 34
Sunnyvale East Channel	0+00 – 111+00	34, 49
Guadalupe Slough	0+00 – 334+00	3, 18, 19, 34
Calabazas Creek	0+00 – 80+00	34, 49
San Tomas Aquino Creek	0+00 – 145+00	34, 49
Guadalupe River/Alviso Slough	190+00 – 330+00	19, 34, 35
Coyote Creek	390+00 – 554+00	5, 20
Lower Penitencia Creek	0+00 – 100+00	5, 20, 21
Berryessa Creek	0+00 – 60+00	20, 21
Calera Creek	0+00 – 20+00	21

RESULTS

Figure 1 illustrates the location of each sampling station (identified from GPS coordinates) and corresponding surface salinity levels (measured at ¼ meter in depth) recorded during the 1998 through 2001 salinity studies. Surface water salinity values were used to generate this figure, since it is anticipated that these salinity levels are what influences the adjacent wetland vegetation. However, salinity values at depth should be considered when evaluating the upstream extent of saline influence on each stream. Figure 2 illustrates the salinity values at depth (< ¼ meter off the bottom) for each sampling station.

As expected, in all four sampling years, salinity levels were highest at the bay-front interface and declined slowly as sampling proceeded upstream (Figures 1 & 2). Of the 16 waterways sampled, only six discharge directly to the South San Francisco Bay (San Francisquito Creek, Permanente Creek, Stevens Creek, Guadalupe Slough, Alviso Slough, and Coyote Creek), seven are tributaries which eventually empty into either Guadalupe Slough or Coyote Creek (Sunnyvale West Channel, Sunnyvale East Channel, Calabazas Creek, San Tomas Aquino Creek, Berryessa Creek, Lower Penitencia Creek, and Calera Creek), one drains to Matadero Creek, and the remaining two are restrained by the Palo Alto Flood-Basin tide gates (Matadero Creek and Adobe Creek). Predictably, waterways which discharged directly to the San Francisco Bay maintained higher salinity levels than the smaller tributaries further upstream. In general, creeks in the northwest flood control zone maintained higher salinity levels further upstream than those in the north-central, central and east flood control zones (Figures 1- 5). A decline in salinity values was apparent moving from west to east along the South Bay margin in all 4 years of the study, with the exception of inexplicable and extremely high salinity values on Guadalupe Slough in sampling year 2000 (Table 3). Unfortunately, boating access to the lower reaches of Alviso Slough and Coyote Creek was unavailable, and therefore a continuous salinity trend along the South Bay interface could not be established.

Table 3. Salinities at Depth (< ¼ meter off the bottom) along the South Bay Interface

Creek	1998	1999	2000	2001
San Francisquito Creek	21.0	25.4	28.2	28.0
Permanente Creek	18.7	20.0	24.7	25.8
Stevens Creek	16.2	17.8	21.1	23.7
Guadalupe Slough	No access	13.8	27.8	No access

* Matadero and Adobe Creeks bayfront salinity values are affected by the flood basin tidegates and therefore their values are not included in this table as they are not indicative of true bayfront salinities.

In general, as surface salinities rapidly declined from one station to the next, measurements at depth maintained elevated salinity values; this phenomenon is referred to as a 'salt-wedge.' Typically, a minor salt-wedge effect was detectable at all sampling stations, but was most dramatic near the brackish and fresh water interface. Ten of the sixteen streams sampled displayed sizeable salt-wedge effects, greater than 1.5 ppt difference, at one or more stations in at least one of the four years of the study (Appendix A). Three of these streams displayed substantial salt-wedge effects, between 2.0 and 21.0 ppt disparity, in all 4 years of the study at the same sampling stations (San Francisquito (St # 8100), Permanente (St # 10300), and Stevens Creeks (St # 8800)). Matadero, Permanente, and Stevens Creeks displayed the most pronounced salt-wedge effects, with the difference between surface salinities and measurements at depth varying by more than 16.0 ppt in some years (Figure 1 – 5 and Appendix A). Of the six streams which showed no sizeable salt-wedge effect in any of the study years (i.e., no gradient > 1.5 ppt), two were deemed completely non-saline (Barron and Calera Creeks), maintaining less than 1.0 ppt at all stations sampled, and the other four streams (Sunnyvale East Channel, Calabazas, San Tomas Aquino, and Berryessa Creeks) did not appear to receive tremendous tidal inundation, maintaining depressed salinity levels, less than 5.0 ppt, at all sampling stations.

The upstream extent of saline influence, i.e., the station furthest downstream on each creek which measured 1.0 ppt or less, varied from year to year on ten streams (Table 4). Two of these streams varied by only one station, i.e., < 1000 feet (Adobe and Berryessa Creeks). Seven of the streams: Matadero Creek, Stevens Creek, Sunnyvale West Channel, Sunnyvale East Channel, San Tomas Aquino Creek, Coyote Creek, and Lower Penitencia Creek differed by 1300 to 3000 feet from one year to the next, and one stream Guadalupe River/Alviso Slough varied by as much as 8000 feet from one year to the next.

Six streams, showed no variation in upstream saline extent from 1998 to 2001 (Table 4). Barron and Calera Creeks, located further upstream in their respective watersheds, were considered non-saline in their entirety with both streams measuring less than 1.0 ppt at their downstream extent. Guadalupe Slough was entirely saline influenced and never achieved a salinity value of less than 1.0 ppt prior to its convergence with Calabazas and San Tomas Aquino Creeks. San Francisquito Creek went dry before it transitioned to freshwater in three of the four years. The remaining 2 streams, Calabazas and Permanente Creeks, showed no variability in the location of the freshwater interface (surface water measurements) in all four years of the study.

During all four years of the study, the more saline reaches of each stream (~ 15-30 ppt) were bordered by perennial pickleweed (*Salicornia virginica*), cordgrass (*Spartina foliosa*), saltgrass (*Distichlis spicata)*, marsh gumplant (*Grindelia stricta* var. *angustifolia*) and alkali heath (*Frankenia salina*). The intermediate brackish areas (~ 5-15 ppt) were composed of a mixture of streamside plants including alkali bulrush (*Scirpus maritimus* and *S. robustus*), California bulrush (*S. californica*), spearscale (*Atriplex triangularis*), and non-native perennial pepperweed (*Lepidium latifolium*). The fresher reaches of each stream (typically < 5.0 ppt) were commonly inhabited cattails (*Typha* spp.), sedges (*Cyperus* spp.) willows (*Salix* spp.), and smartweed (*Polygonum* sp.).

Table 4. 1998 - 2001 First Sampling Stations where Surface Salinities were ≤ 1.0 ppt.

Creek/Channel	**~ 1993 "Yellow Book" Station Number ***	**1998 Surface Salinity (ppt)**	**1999 Surface Salinity (ppt)**	**2000 Surface Salinity (ppt)**	**2001 Surface Salinity (ppt)**
San Francisquito Creek	10000	**0.6**	dry	dry	dry
Matadero Creek	7000	3.2	**1** (19.8)	8.4	8.5 (10.6)
	8400	1.2	0.6	9	6.3 (9.2)
	9000	**1**	0.6	**0.8**	2.2
	9700	0.5	0.6	0.4	**0.7**
Barron Creek	0	**0.4**	**0.6**	**0.6**	**0.5**
Adobe Creek	12300	**0.6**	1.1	**0.9**	1.1 (2.8)
	13000	0.6	**0.6**	0.6	**1**
Permanente Creek	11500	**0.6**	**0.7**	**0.7**	**0.5**
Stevens Creek	8800	1.2 (5.8)	**0.9** (14.8)	5.5 (17.7)	8.8 (18.9)
	9800	**0.5** (8.0)	0.4	**0.9** (6.5)	3.5 (15.4)
	10800	0.4	0.4	0.6	**0.5**
Sunnyvale West Channel	5300	**0.9**	**0.9**	1.6 (8.7)	**0.9**
	5500	0.9	0.8	2.2 (7.5)	0.9
	6600	0.7	0.7	**0.9** (5.8)	0.6
	8000	-	0.7	0.7	-
Sunnyvale East Channel	6000	**1**	1.2	2.1	**1**
	7000	0.8	**0.8**	1.6	0.6
	8000	0.6	0.6	**0.7**	0.6
Guadalupe Slough	n/a	n/a	n/a	n/a	n/a
Calabazas Creek	4500	**0.6**	**0.5**	**0.6** (1.6)	**0.7**
	4900	0.6	0.5	0.5	0.5
San Tomas Aquino Creek	6000	1.1	1.5	1.9	**0.9**
	7000	1.1	1.3	1.7	1
	8000	**0.8**	1.1	1.6	1
	9000	0.6	**0.9**	**0.6**	0.6
Guadalupe River	21000	6.6 (8.0)	3.9 (5.3)	**1** (2.7)	8.3 (11.0)
	22700	6.6 (7.9)	2.5 (3.6)	0.8 (2.0)	6.5 (8.5)
	25000	3.5	1.1	0.4	3.3
	26000	1.3	**0.9**	0.3	1.9
	27200	**0.9**	0.8	0.3	1.3
	29000	0.7	0.6	-	**0.9**
Coyote Creek	50000	4.6	**0.9** (3.6)	**0.8** (2.6)	4
	50700	2.8 (4.5)	0.8	0.6	2
	52000	1.1	0.6	0.6	**0.8** (2.2)
	52700	**0.8**	0.6	0.5	0.6
Lower Penitencia Creek	3200	2.7	3.1	2.9	**0.9**
	4200	1.1	2.6	2.2	0.7
	5000	**0.8**	1.4	1.3	0.6
	6200	0.7	**0.7**	**0.9**	0.8
Berryessa Creek	0	2.9	**0.9**	1.1	**0.6**
	1000	**0.7**	0.8	**0.7**	0.6
Calera Creek	0	**0.8**	**0.8**	**0.7**	**0.6**

* "Yellow Book" stationing is the approximate distance upstream from the mouth of each channel in feet.

** Values in bold represent the first salinity reading (i.e., the station furthest downstream) which measured 1.0 ppt or less for each creek during 1998, 1999, 2000, and 2001 sampling.

*** Values with adjacent numbers in parentheses had greater salinities at depth than at the surface, i.e., greater than 1 ppt difference. Bottom salinity values are in parentheses.

DISCUSSION

The sampling data shows that salinity levels have increased slightly along the South Bay margin since the 1998 study (Figures 1 & 2). This trend is consistent with preliminary water quality data collected by the United States Geological Survey (USGS) at the Newark Slough (Station 34: latitude 37°29.7'; longitude 122°5.6') and Calaveras Point (Station 36: latitude 37°28.3'; longitude 122°3.9') sampling stations in the South San Francisco Bay (Table 5). The extreme rains and freshwater influx from the 1997-98 El Nino weather patterns appear to have caused the decline in salinity levels throughout the entire San Francisco Bay for the 1998 water year (Table 1: 24.3 – 78.4 inches of rain). However, salinity levels appeared to bounce back in 1999 through 2001 with salinity ranges similar to pre-El Nino conditions (~ 29 ppt).

Table 5. USGS San Francisco Bay Water Quality Data - Range of Salinities per Year (ppt)

Station Number	1998 (Aug – Dec)	1999 (Aug – Nov)	2000 (Aug – Dec)	2001 (Sept – Dec)
Station 34: Newark Slough	19.69 – 25.59	26.85 – 28.99	27.07 – 28.51	25.20 – 30.44
Station 36: Calaveras Point	19.47 – 24.88	26.70 – 27.89	25.65 – 27.63	26.13 – 29.61

* Data available on the USGS website: http://sfbay.wr.usgs.gov/access/wqdata

Although overall salinity values generally increased from the 1998 values, the added influx of salt did not drive the extent of saline influence further upstream. Six creeks showed no difference in saline extent from 1998 to 2001, while 10 streams showed variable upstream saltwater influence from 1998 to 2001 (Table 4).

According to the data from 1998 – 2001 there appears to be a decline in salinity along the South Bay margin, moving west to east from Palo Alto (San Francisquito Creek) to Sunnyvale (Guadalupe Slough; Table 3). Access to the lower reaches of Alviso Slough and Coyote Creek were unavailable, and therefore no complete trends along the entire South Bay margin could be established. In future studies, it would be beneficial to sample further downstream along Alviso Slough and Coyote Creek, to see whether a continuous shift in salinity levels exists along the Bay margin from Palo Alto to Milpitas (i.e., west to east in the South Bay).

The salt-wedge effect was most pronounced at the brackish water/ freshwater interface varying in some years by more than 16.0 ppt on Matadero, Permanente, and Steven Creeks. Half of the streams sampled displayed sizeable salinity gradients (> 1.5 ppt) in at least 2 of the 4 years of sampling. Since the salt-wedge can be quite pronounced at the brackish water/ freshwater interface in the upper reaches of each stream, further studies on salinity trends should consider salinity levels at depth when evaluating the maximum extent of upstream saline influence on each stream.

Locations of specific salinity levels and the extent of salinity influence are variable over very short, as little as hourly, and long periods of time. Tidal heights and salinity levels fluctuate yearly, seasonally, and diurnally due to a multitude of variables including: recent rainfall, annual rainfall, urban runoff and other anthropogenic water inflow, and large scale climatic and gravitational conditions. Salinity deviations can be caused by any one or a combination of these variables. For example, the 1999 sampling season registered higher salinity values than the 1998 season almost throughout the entire study area. However, the Guadalupe River measured lower salinity levels in 1999 than in 1998. This discrepancy in salinity values may have been the result of sampling on a substantially lower tide in 1999 (5.5′ tide) than in 1998 (6.3′ tide). Berryessa Creek also registered slightly lower salinities in 1999 than in 1998. This result was very likely caused by a large freshwater influx from a nearby freshwater pond owned by the city of Milpitas. Berryessa Creek was sampled three times in 1999 and every sampling time (i.e., the tidal cycle) coincided with the city's freshwater pond discharges. Anthropogenic factors such as outfall pumping and sewage treatment output which can contribute to salinity fluctuations should be acknowledged in future salinity studies.

Establishing a fixed point on each stream from which to determine the tidal status (i.e., incoming, slack, or outgoing) would be beneficial in future studies. This would provide a more accurate, fixed account of the timing of the tidal cycle in the South Bay.

All creeks which can be canoed or boated safely should be sampled this way in future studies. This method allows you to sample from the center of the channel, providing better information on salinity levels and salt-wedge effects. In addition, this method is much safer than walking extensive distances through marsh vegetation.

Sampling over a longer interval (i.e., a full tidal cycle) using an automated data logger may be beneficial in establishing the tidal delay for each flood control zone in the county or for each individual stream. This methodology could provide more accurate salinity readings by sampling throughout an entire tidal cycle and recording maximum salinity levels for each tide. However, this method can be very expensive, so the cost-to-benefit ratio should be assessed for further studies.

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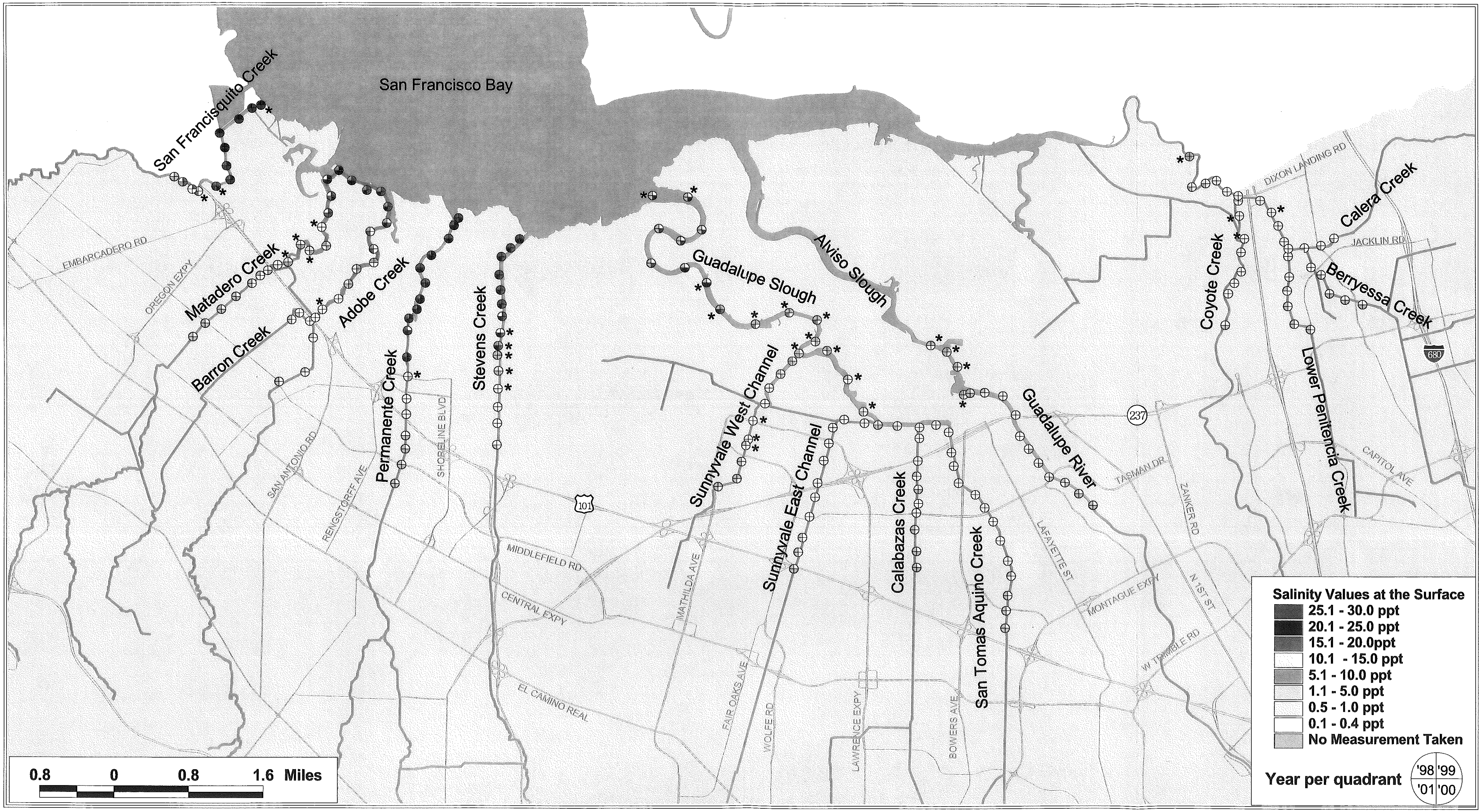
United States Geological Survey, Water Quality of the San Francisco Bay : http://sfbay.wr.usgs.gov/access/wqdata. Data utilized from 1999- 2001.

Figure 1. 1998-2001 Sampling Locations: Surface Salinity Values (< 1/4 meter in depth)



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* Stations where salinity values at depth were >1.5 ppt higher than surface salinities in at least one year of the study.

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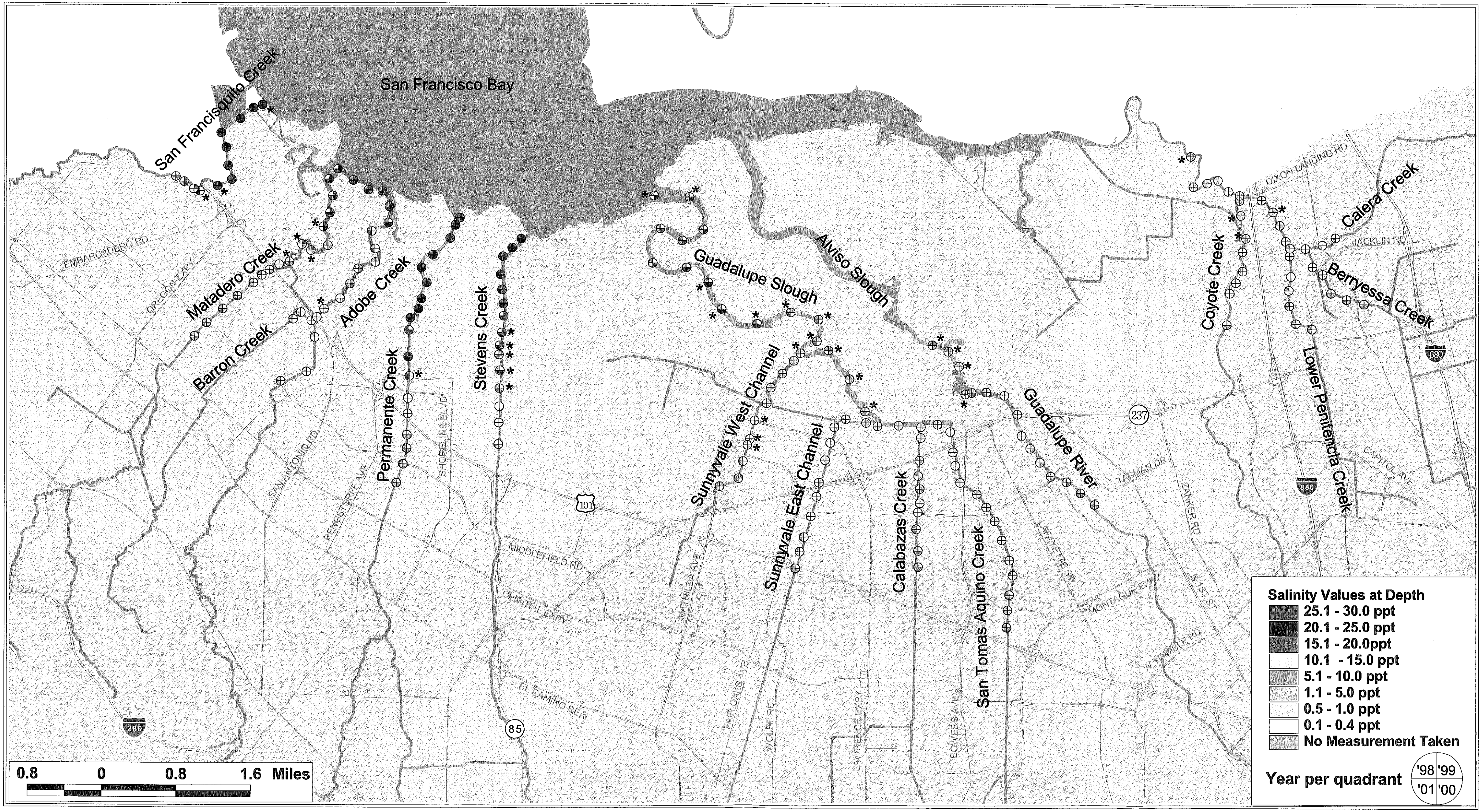
Figure 2. 1998-2001 Sampling Locations: Salinity Values at Depth (< 1/4 meter off the bottom)



* Stations where salinity values at depth were >1.5 ppt higher than surface salinities in at least one year of the study.

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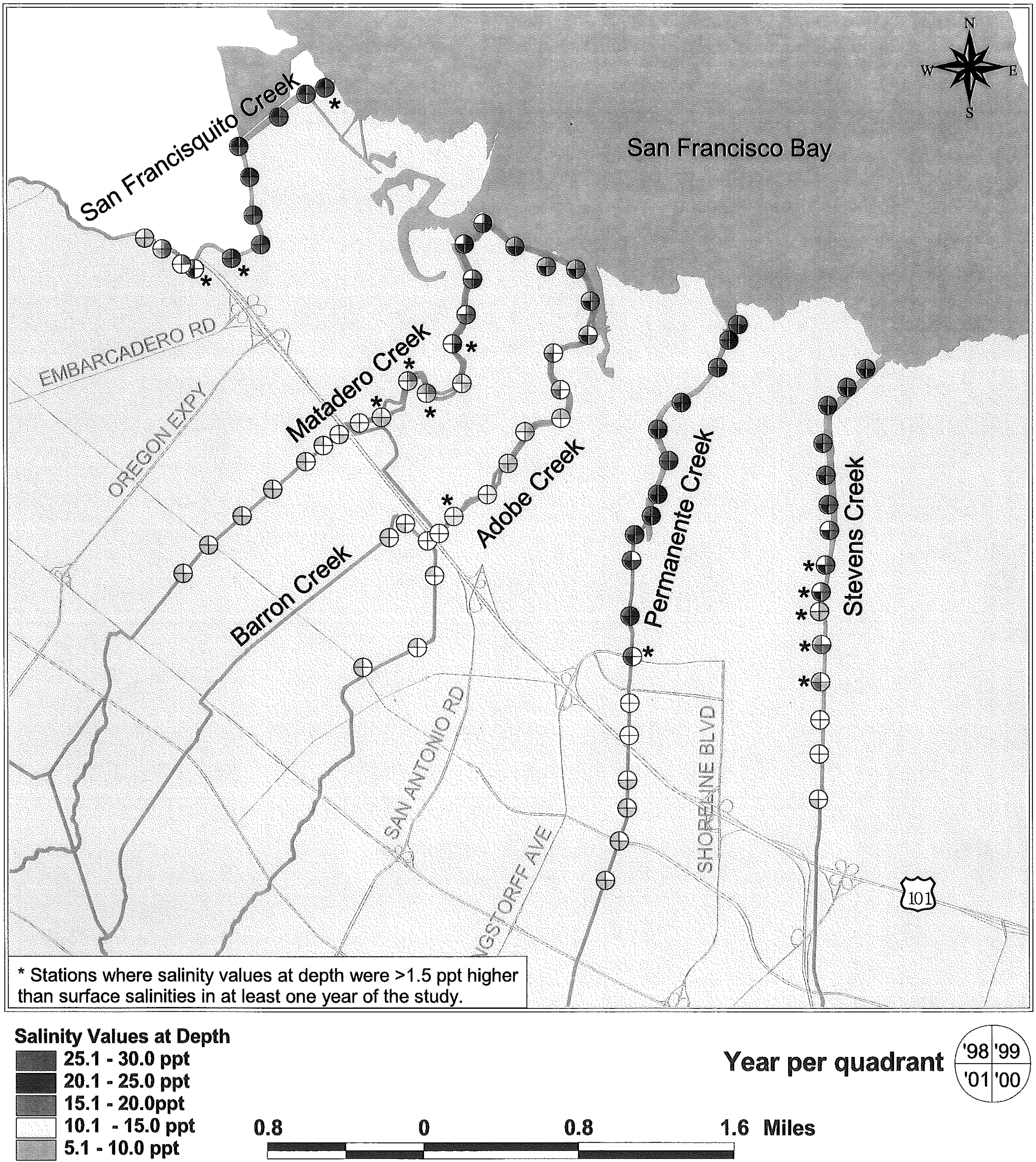
Figure 3. Salinity at Depth (< 1/4 meter off the bottom) Northwest and West Flood Control Zones



* Stations where salinity values at depth were >1.5 ppt higher than surface salinities in at least one year of the study.

Salinity Values at Depth

- ▨ **25.1 - 30.0 ppt**
- ▨ **20.1 - 25.0 ppt**
- ▨ **15.1 - 20.0ppt**
- ☐ **10.1 - 15.0 ppt**
- ▨ **5.1 - 10.0 ppt**
- ▨ **1.1 - 5.0 ppt**
- ▨ **0.5 - 1.0 ppt**
- ☐ **0.1 - 0.4 ppt**
- ▨ **No Measurement Taken**

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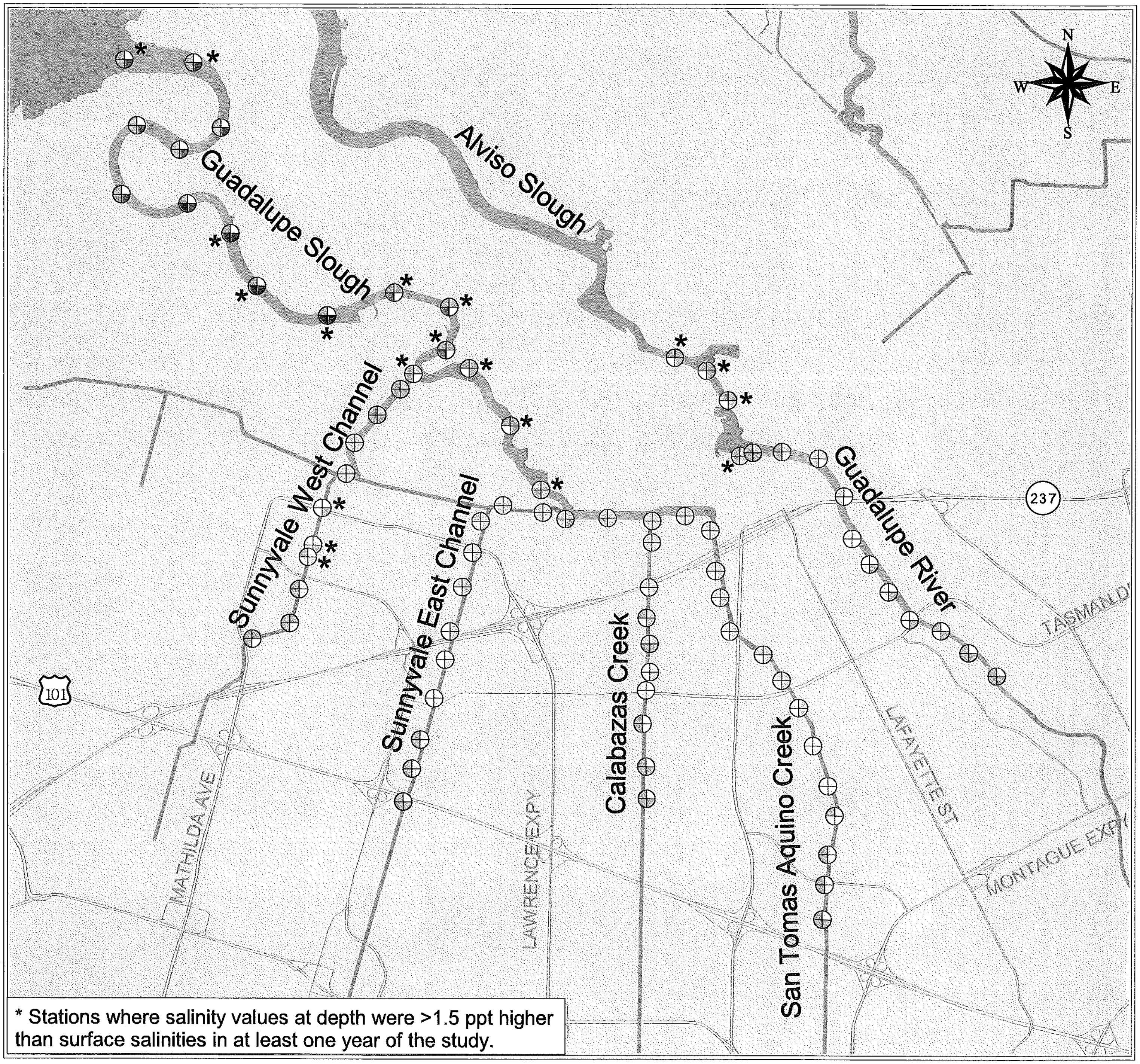
Figure 4. Salinity at Depth (< 1/4 meter off the bottom) North-Central and Central Flood Control Zones



* Stations where salinity values at depth were >1.5 ppt higher than surface salinities in at least one year of the study.

Salinity Values at Depth

- ▨ 25.1 - 30.0 ppt
- ▨ 20.1 - 25.0 ppt
- ▨ 15.1 - 20.0ppt
- ☐ 10.1 - 15.0 ppt
- ▨ 5.1 - 10.0 ppt
- ▨ 1.1 - 5.0 ppt
- ▨ 0.5 - 1.0 ppt
- ☐ 0.1 - 0.4 ppt
- ▨ No Measurement Taken

Year per quadrant

'98	'99
'01	'00

1 0 1 2 Miles

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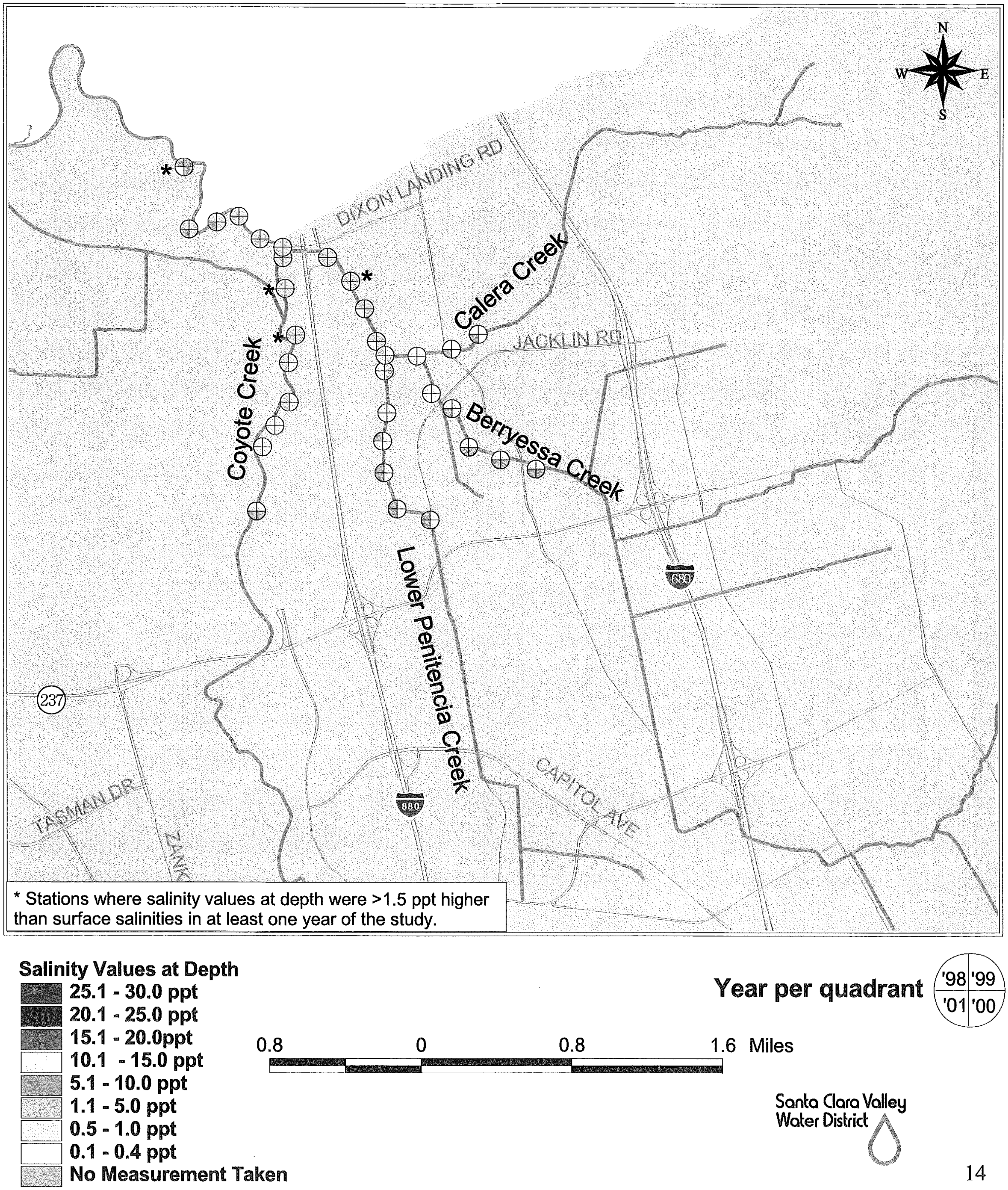
Figure 5. Salinity at Depth (< 1/4 meter off the bottom) East Flood Control Zone



* Stations where salinity values at depth were >1.5 ppt higher than surface salinities in at least one year of the study.

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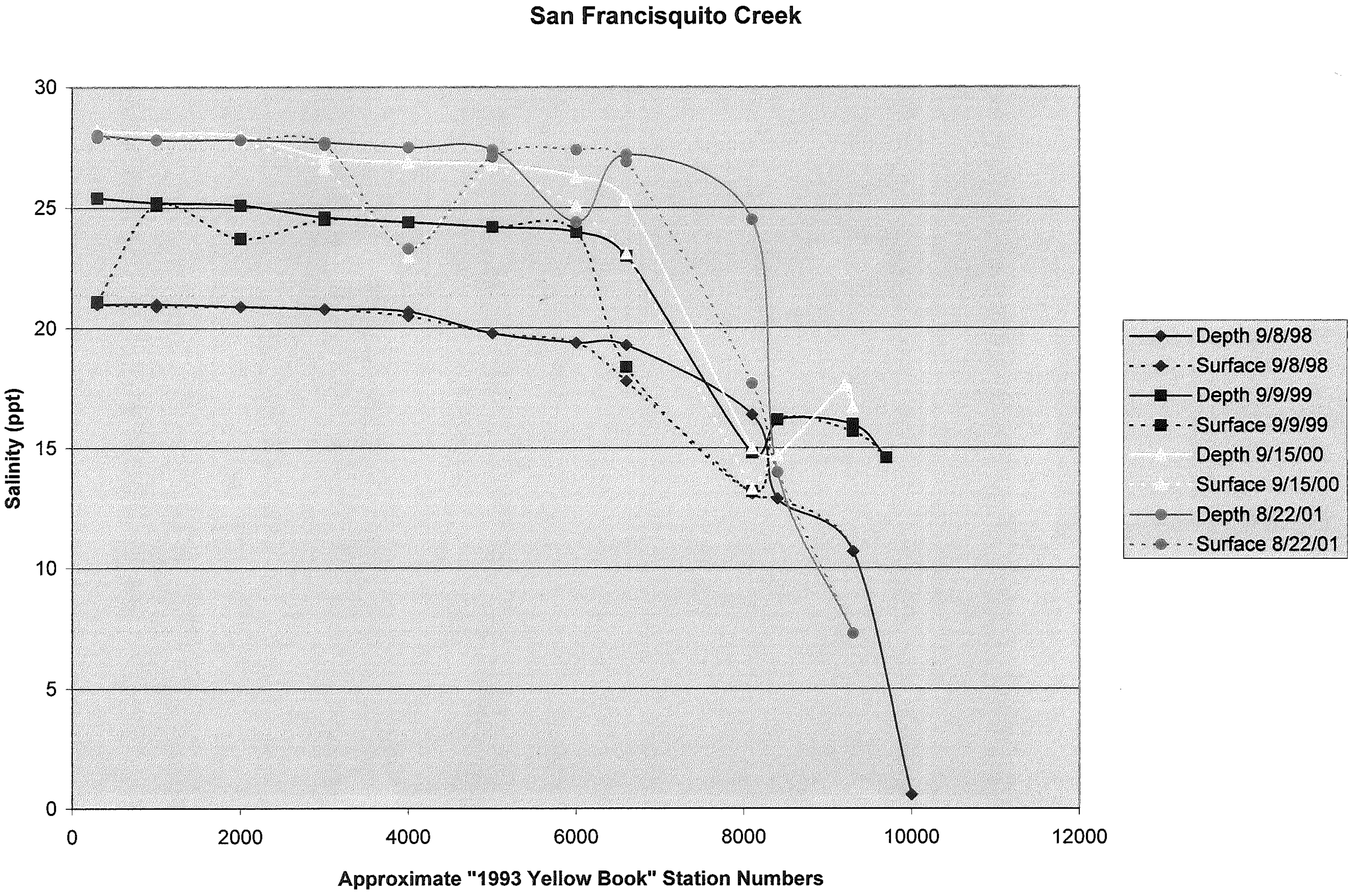
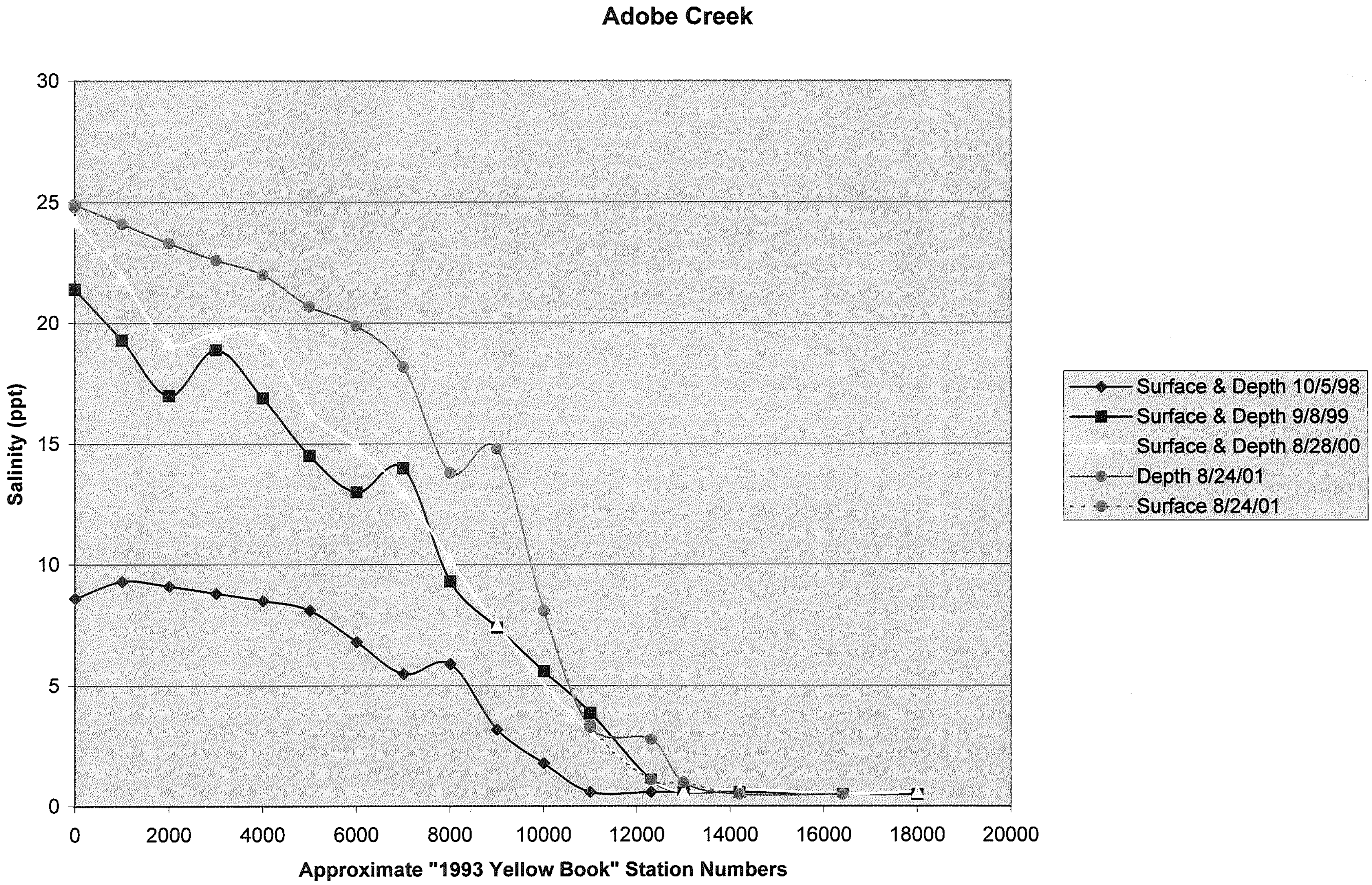
Water District

APPENDIX A
1998 – 2001 Salinity Gradient on Each Stream

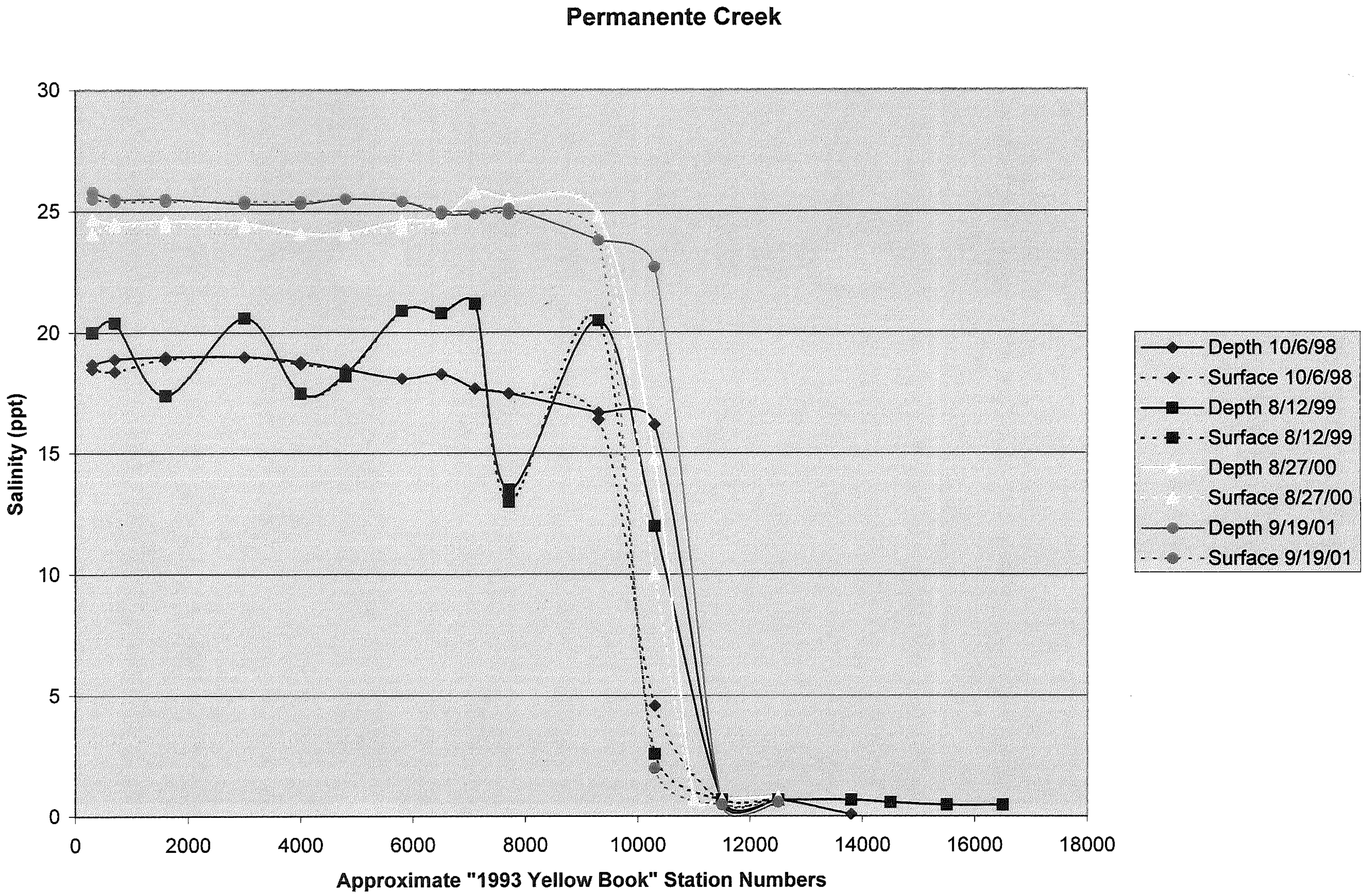


Four year comparison (1998-2001) of salinity measurements along San Francisquito Creek.



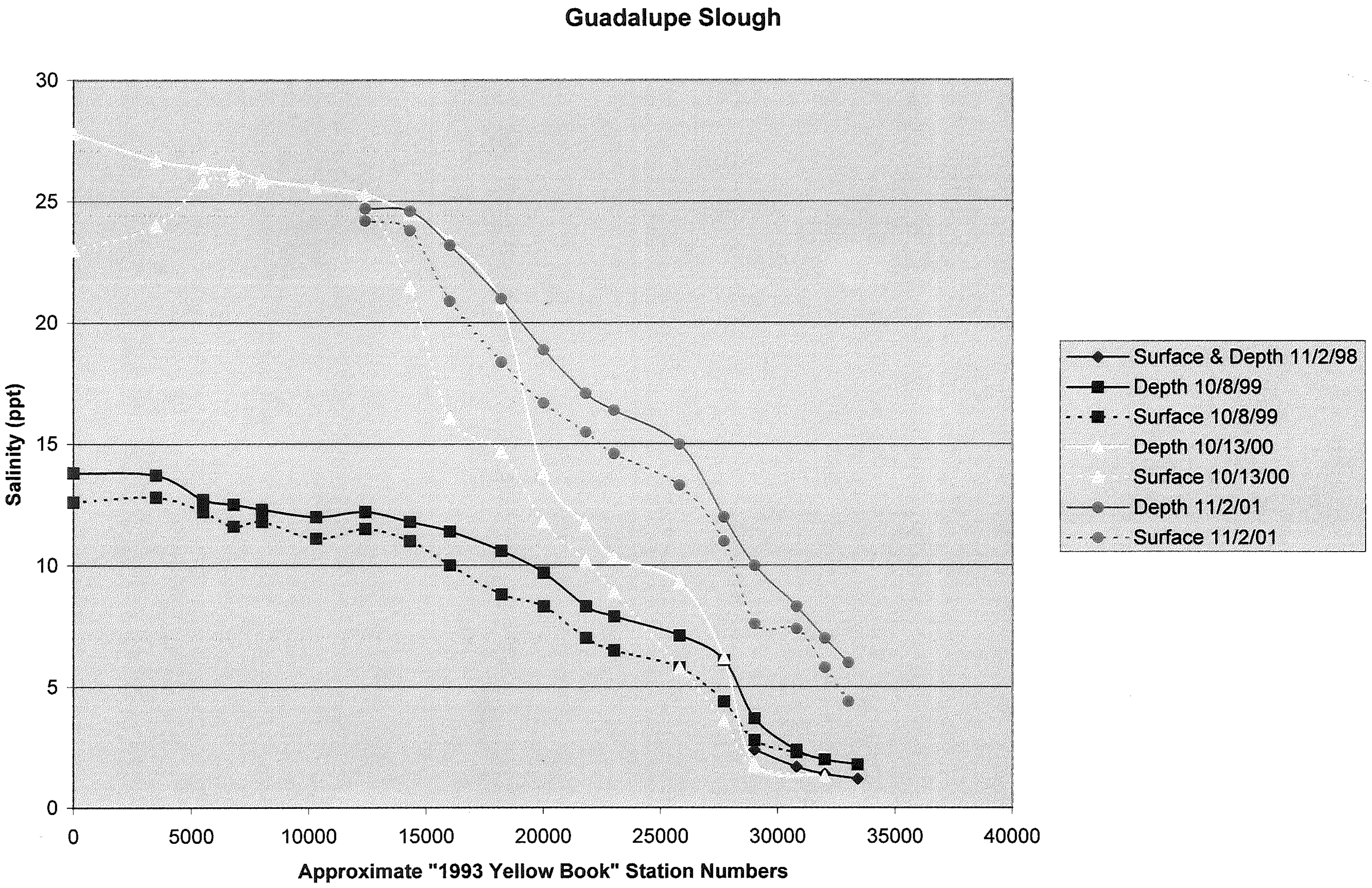
Four year comparison (1998-2001) of salinity measurements along Adobe Creek.

Appendix A

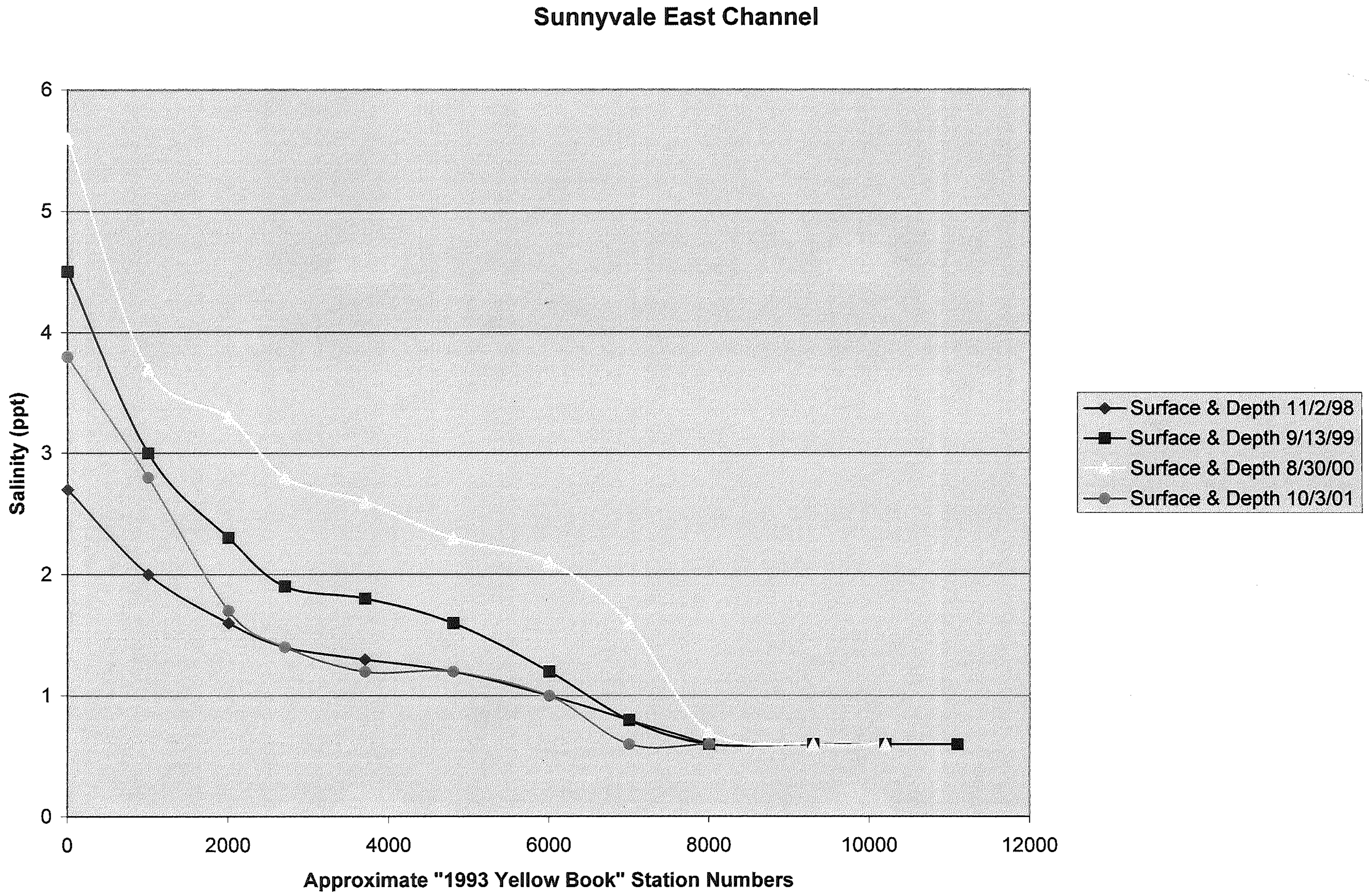


Four year comparison (1998-2001) of salinity measurements along Permanente Creek.

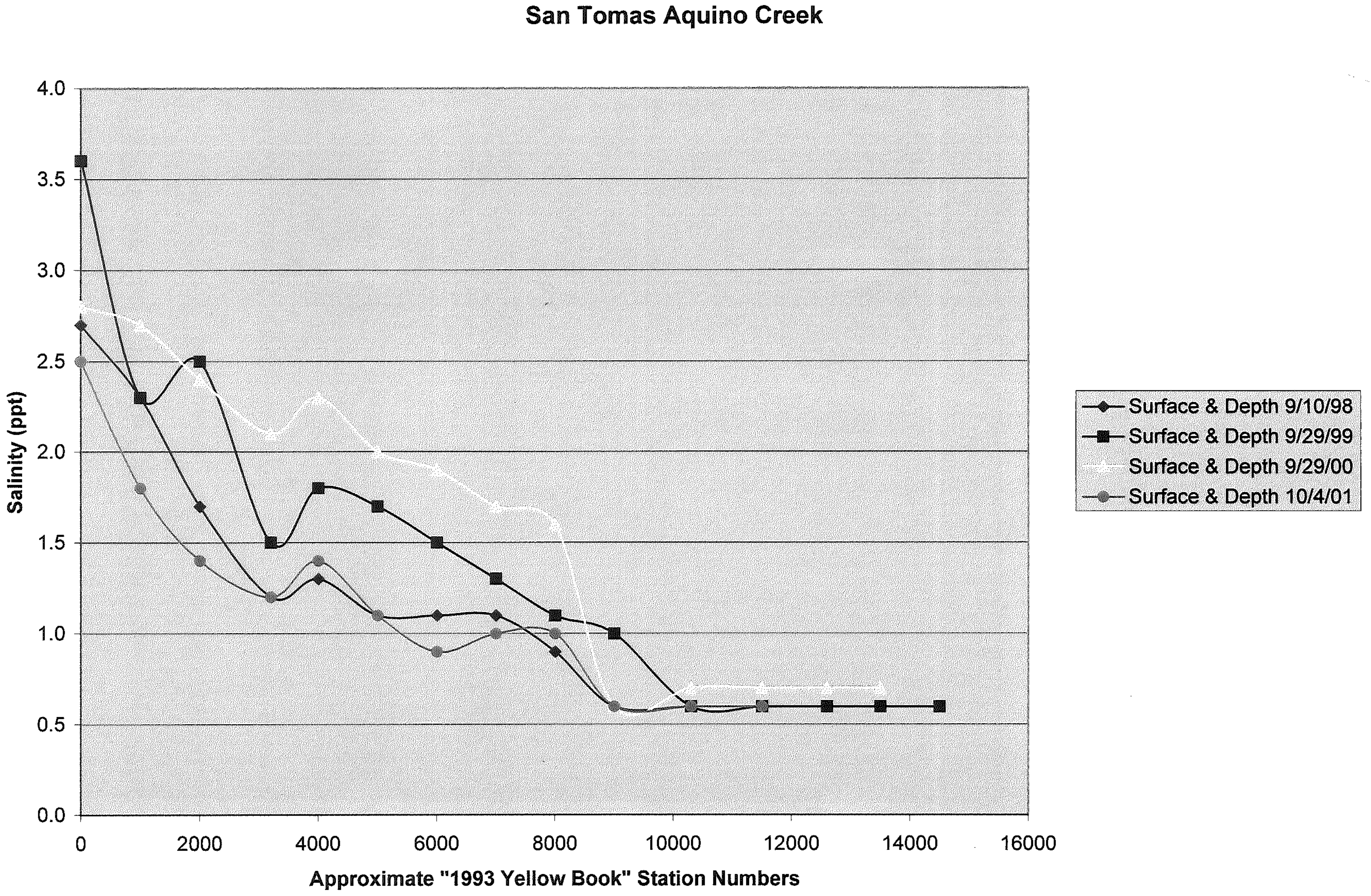
Appendix A



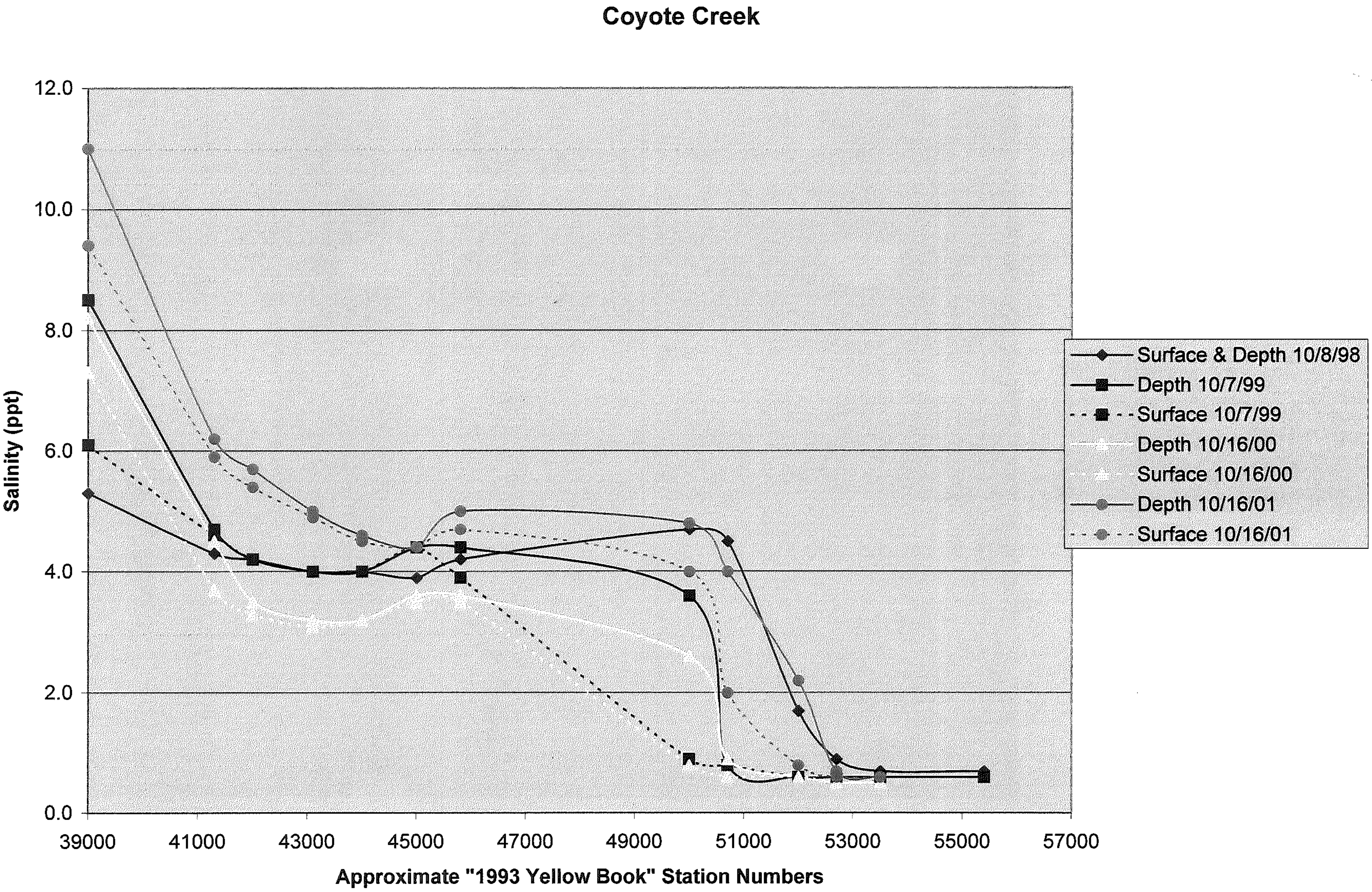
Four year comparison (1998-2001) of salinity measurements along Guadalupe Slough.



Four year comparison (1998-2001) of salinity measurements along Sunnyvale East Channel.

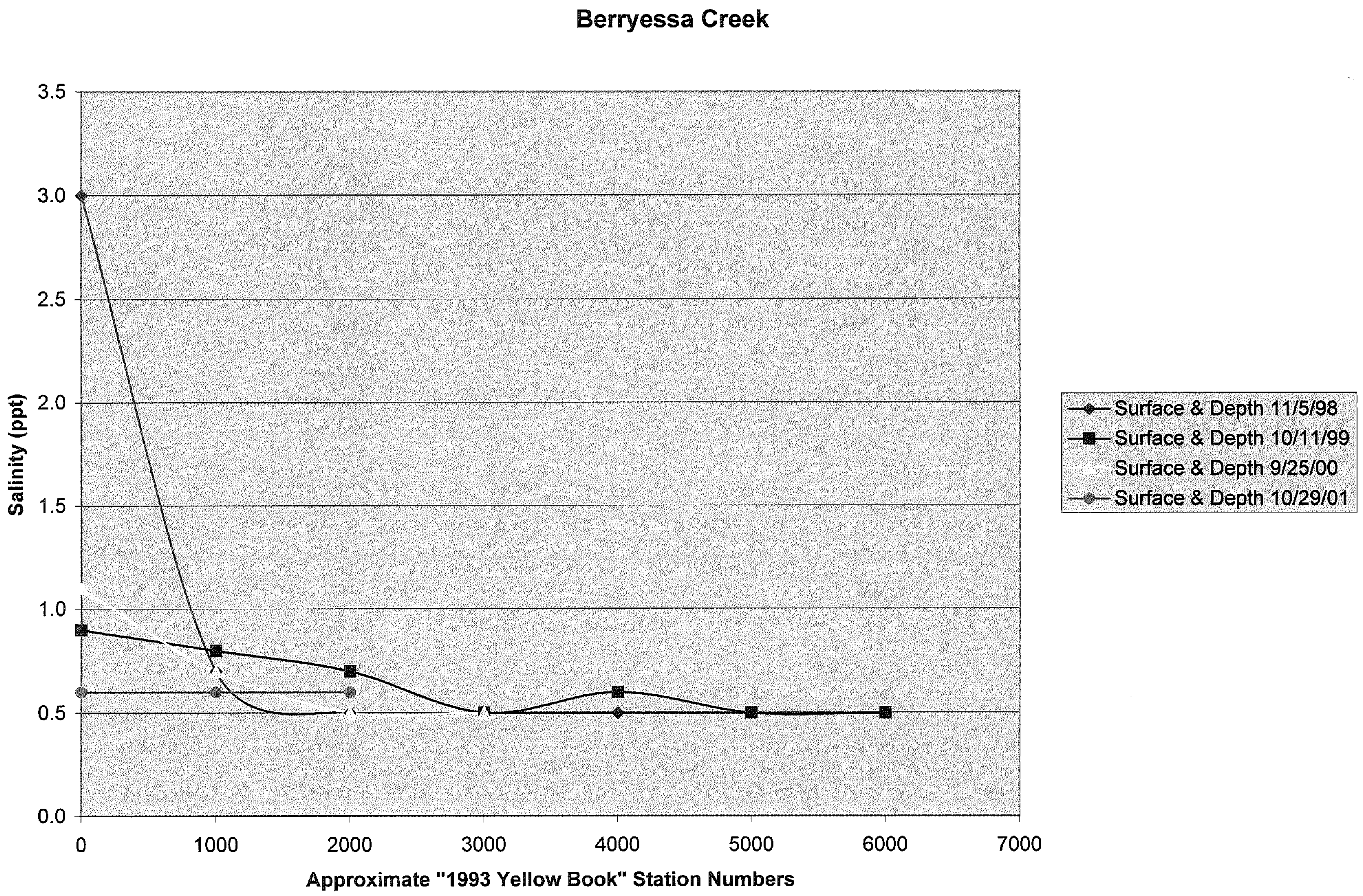


Four year comparison (1998-2001) of salinity measurements along San Tomas Aquino Creek.



Four year comparison (1998-2001) of salinity measurements along Coyote Creek.

Appendix A



Four year comparison (1998-2001) of salinity measurements along Berryessa Creek.

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